On-line Decision Support Fuzzy Systems: An Application to Product Pricing

Gomes, Rogério; Pacheco, Roberto; Martins, Alejandro; Weber, Rosina; Barcia, Ricardo

Federal Univ. of Santa Catarina - Graduate Program in Production Engineering (PPGEP/UFSC), Florianópolis, SC - BRAZIL, Phone/Fax: +55 48-331-7010

Abstract

The extremely fast development of software tools in the last few years has open a completely new perspective for computing systems. The emergence of commuting languages such as *Perl* and *Java* has made possible the development of on-line systems running as cross-platform programs. In this article we present an example of such systems: a commuting system for cost analysis. The system provides an analysis of the cost structure of a firm and can be accessed through the Internet as an on-line application.

The aim of the application presented in this paper is to perform product pricing evaluation. The fuzzy system evaluates an *initial* product pricing which is the result of a contribution margin entered by the user. After iterative cycles, the system reaches a pricing decision; the latest decision is such that a contribution margin correction is no longer necessary. At this point, the fuzzy system returns a pricing suggestion to the user. This answer is associated with a contribution margin value and with a rate of return forecast.

Keywords: *Intelligent Systems, Fuzzy Systems, commuting languages, JAVA, product pricing*

1. Introduction

The born of new technologies has always open new frontiers in several fields of Science. In the last few years, Internet has been the most exciting technological advance. It begun as an information exchange system and very quickly became widely used by academia as well as by industry. Although the availability of the information was by itself the main cause for the boost of the Internet, soon it became clear that an "information avalanche" would require better interfaces, putting the user no longer on a passive position but offering dynamic and interchangeable information. The Internet should become more than a large Hypertext database. It should accept systems with data exchange information between users (*clients*) and senders (*servers*). As a result, *commuting languages* were created in order to make possible the development of systems running in several platforms without recompilation. Business is one of the most important targets for network systems, with applications ranging from simple cybernetic shopping to sophisticated remote consulting.

The growing of such computational environments has brought new challenges to several areas of Computer Science. Particularly in Computational Intelligence, the first demands were related to the need for intelligent agents capable of facilitating the access to large amounts of data in the net [3] and making the Internet transparent to the users [5]. Intelligent agents were and are being built to search for information automatically based upon user's settings. The development of commuting languages extended these capabilities. As it is beginning to happen with all information systems, the AI programs can now be implemented to run as cross-platform and remote accessed systems. The brand new technologies dedicated to improve communication and quality of Internet resources are not being neglected by the AI community. In this article we discuss such advances and how AI systems can take advantage of them. We point out the

expected features of commuting programs, particularly, the object-oriented architecture and programming. We also discuss the impact of the new forms of accessing intelligent systems, particularly in the business environment. The article presents an example of the implementation of intelligent commuting systems: a commuting fuzzy system for cost analysis. The system provides an analysis of the cost structure of a firm and can be accessed through the Internet as an on-line application.

2. New Trends on Information Technology and the Role of Intelligent Systems

It took almost four decades until the Information Technology reached the point we are. It started with the mainframe computing age in the 1960s and 1970s (*first age*). In the 1980s it was highly influenced by the desktop PC revolution. The "marriage" between the distributed paradigm of the first age with the PCs availability led to the client-server model (*second age*) [4]. In the last years there has been a demand for information management, office automation, concurrent engineering, and, particularly, collaborative workgroup. Among the technological alternatives we find the distributed client/server architectures which lets users of geographically remote sites using individual, networked computers share programs and data resources [1]. Internet has a clear role in this new trend: to boost the business's communication and market capabilities. What was initially most an electronic-mail resource became a valuable means for software distribution and Web communication. A recent research indicated that firms are planning to do a lot more than electronic mail and information. Several companies are involved in electronic commerce and have created a department exclusively dedicated to Web creation [10].

The next step in the Internet and, consequently, in Information Technology was the born of the so-called *network languages* or *commuting languages.* The aim was integrate users using different platforms in geographically separated sites, allowing data and program sharing. Maybe the first language to reach such status was *Perl* (short for "Practical Extraction and Report Language") developed by Larry Wall [11]. Perl is an interpreted language optimized for scanning arbitrary text files for information extraction, and report generation. Its primary intention was to become a system administration language for quickly development of utility programs, but the popularity of Internet led Pearl to be intensively used as a front-end and Web server language professional language. In 1995, Sun Microsystems developed *JAVA*, a programming language entirely devoted to compile programs into a binary format to be portable across multiple platforms without recompilation. The result was a portable, interpreted, simple, and object-oriented language that made possible the development of systems to run on client machines with the server located on a geographically remote site [6]. In Table 1 we describe some examples of use of JAVA in business sites at the Internet.

Table 1: Internet Applications of JAVA.

Company	Electronic Address	Description
WallStreetWeb BulletProof	http://www.bulletproof.com/wallstreetweb	it allows on-line monitoring of stock movements.
ProminenceDotcom, Virtual Service Rep	http://prominence.com	it integrates Java and database to work as a Customer Service Representative.
Datamation	http://www.datamation.com	On-line publication dedicated to Information System information where Java plays a central role as subject and empowerment tool for the magazine
Interactive Agency	http://arachnid.qdeck.com/qdeck/products/wc20/	on-line marketing and creation of interactive entertainment and web services.

The examples in Table 1 reflect the fact that network programming is in its first stage, with the applications being mainly dedicated to improve Web interfaces and cybernetic marketing. Nevertheless, in near future practically all areas of Information Technology will take advantage of these new trends in programming language. Distance education can be improved by the development of remote tutorial systems based on multimedia or

intelligent digital libraries [2]; Business can make use of remote systems to pursue trading, marketing and information exchange; and Research can be enhanced by means of a whole proliferation of systems in the most diverse areas of knowledge and more importantly by full collaboration regardless geographic distances [9]. It is in this context that Intelligent Systems have to be viewed in the next years: all these advances require the empowerment of searching capabilities [5], distributed problem solving [3], hardware-software integration among remote platforms [7], and Internet availability of intelligent systems to a varied source of needs. These concerns can already be noticed by the appearance of a variety of Internet sites using agents[1]. In the next sessions we present an example of the benefits and perspectives of the use of intelligent systems implemented as commuting programs.

3. Fuzzy cost analysis through Internet

The following is an example of an intelligent networking system that implements Fuzzy reasoning applied to a business application. The aim of this application is to perform product pricing evaluation. The system uses a total of four fuzzy variables (three premises and one consequent). A brief description of the variables is presented in Table 2.

The *nature* of the rules is dependent on the user selection of strategic policy of sales. The user has three possible alternatives of sales policy: *aggressive, moderate,* and *conservative* policy. Each policy may define different consequent for a same set of a fuzzy premises.
The list of the production rules for the *aggressive* policy is presented on the Appendix A. Figure 2 shows how the fuzzy inference is performed by the system. After iterative cycles, the system reaches a pricing decision; the later decision is such that a CM correction is no longer necessary to be made. At this point the fuzzy system returns to the user a pricing suggestion, which in turn is associated with a contribution margin value and a rate of return forecast. Appendix B brings the Java code for this system. It should be noticed that the object-oriented paradigm has implemented a concise and adaptable code to the fuzzy expert system. Such features are essential to commuting intelligent systems due to the need for easy maintenance and, mainly, for running as cross-platforms systems. These goals have been guided several researches in applying the object-oriented paradigm to artificial intelligence systems (e.g., [12] and [8]).

[1] A good example is the site http://cwsapps.fibr.net/agents.html, with a collection of intelligent agents.

Aggressive Policy

If sales is Medium AND price is High AND return is (Low OR Medium) THEN CM correction is P

Moderate Policy

If sales is Medium AND price is High AND return is (Low OR Medium) THEN CM correction is PP

Figure 1: Different firm's policy depending on the sales policy

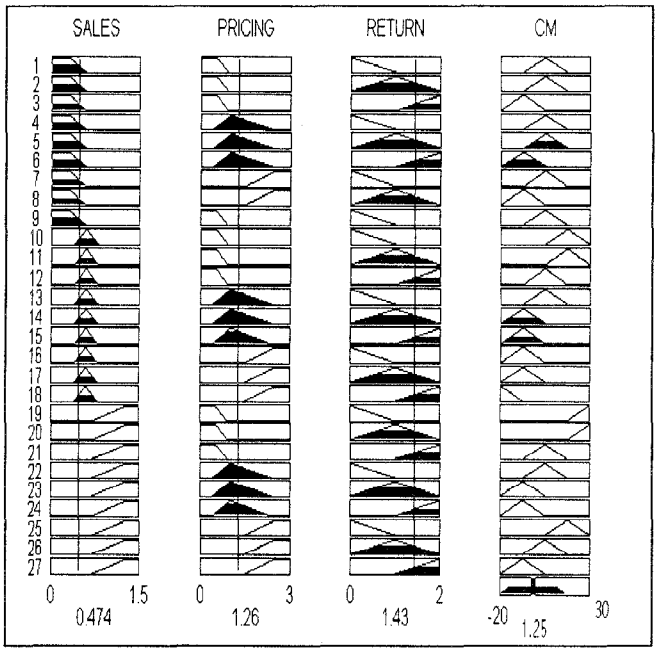

Figure 2: An example of the fuzzy inference performed by the system (*Aggressive* policy).

Table 1: Variables used by the system to determine the *final* product pricing.

Variable, "Name"	Fuzzy Sets	Unit
Sales forecast, "Sales"	L, M, H	current monthly sales forecast/ actual sales of the same month, a year before
Product pricing estimation,	L, M, H	trial pricing of the product/ pricing

"Price"		reference
product rate of return (forecast), "Return"	L, M, H	trial product rate of return / rate of return
Contribution margin correction, "CM correction"	NN, N, Z, P, PP	percentage to be added (subtracted) to the trial contribution margin

L, M, H: "Low", "Medium", "High"

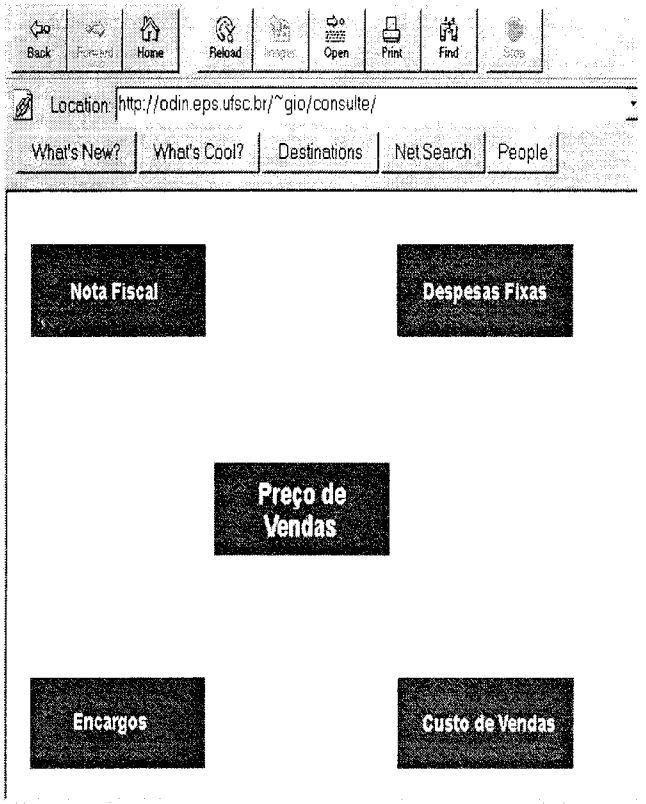

Figure 3: General interface; retail pricing.

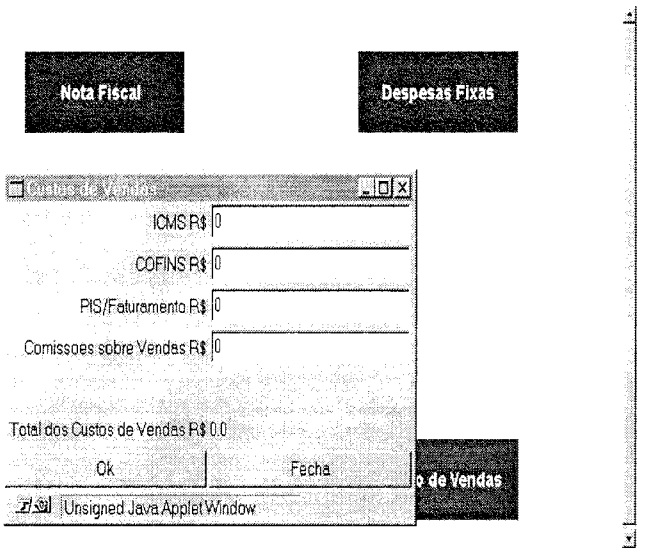

Figure 4: User interface for the input data: *cost of sales*.

4. Concluding Remarks

The born of a new generation of computer languages, the commuting languages, has created an entire new frontier to all areas of Computer Science and Business. Computational Intelligence is not an exception. The first developments shown that intelligent agents can help the user to recover and select significant data among the large amount information available on the Internet or even perform the search on their own based on previous settings. The next step is the implementation of commuting intelligent systems capable of running as cross-platform programs exchanging data and knowledge among geographically separate users. In this article we presented an example of how the marriage of commuting languages, such as Java, and object-oriented intelligent systems can bring such promise to reality. Based on linguistic variables describing firm's sale policy and financial data, the fuzzy commuting system informs the expected contribution margin of a product regarding certain pricing policy. The most relevant aspect is that the intelligent system performs this task regardless location or machine model hold by the user. In the next few years, a whole flow of commuting intelligent systems will be available on the Internet, putting intelligent systems even closer to business than it is today.

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Appendix A - Fuzzy Knowledge Base Implemented for an "Agressive" Policy of Sales.

Table A-2: Delta Margin

	Profit Forecast		
Price	LOW	MEDIUM	HIGH
LOW	P	P	Z
MEDIUM	Z	N	N
HIGH	N	N	NN
When Sales Forecast is MEDIUM			

Table A-1: Delta Margin

	Profit Forecast		
Price	LOW	MEDIUM	HIGH
LOW	Z	Z	N
MEDIUM	Z	Z	N
HIGH	Z	N	N
When Sales Forecast is LOW			

Table A-3: Delta Margin

	Profit Forecast		
Price	LOW	MEDIUM	HIGH
LOW	Z	Z	N
MEDIUM	Z	Z	N
HIGH	Z	N	N
When Sales Forecast is HIGH			